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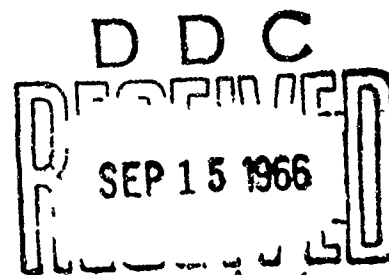
## THE EFFECTS OF PAREDINE ON NIGHT VISION TEST PERFORMANCE

Report on Project X-226 (Av-123-11)

Report No. 1  
prepared by

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THE EFFECTS OF PAREDRIINE  
ON NIGHT VISION TEST PERFORMANCE

SUMMARY

1. By direction of Bureau of Medicine and Surgery Research division Project No. X-226(AV-123-W), a series of experiments has been performed to determine the effect of the mydriatic drug, paredrine, on night vision test performance.

2. The results of adaptometer tests indicate that the use of this drug is associated with improved performance on such tests of night vision. This improvement is statistically significant.

THE EFFECT OF PAREDRIINE  
ON NIGHT VISION TEST PERFORMANCE

PART ONE

Summary:

In a first experiment on the effect of the mydriatic drug paredrine on night vision test performance, a group of 17 sophisticated subjects was employed. A statistically reliable improvement in performance appeared after the administration of the drug. The data are equivocal since similar improvements had previously appeared, but not in association with use of the drug.

A. PROCEDURE:

1. Seventeen subjects highly experienced in night vision were employed. These men had previously been tested on various adaptometers numerous times, and they had had an intensive course of instruction on the use of the eyes at night. Their standards of performance and their variability are both known. They constitute a sample of the population which does not include any men whose performance is consistently so low that they might be classed as not qualified for performance of night lookout duties.

2. The experiment was performed over the period 24 January through 27 January, 1944. On both morning and afternoon of each experimental day, each man was tested on three different adaptometers, the Navy Radium Plaque Adaptometer, and the NDRC Model II-A and Model III. Fifty trials were administered on the first, and 20 trials at each of three brightness levels on the latter two. On the second day, paredrine was administered\* at 0630, at 1130, and at 1700, insuring complete effectiveness of the drug throughout the whole day and early evening. At all times through the second and third days, dark green goggles were worn by the subjects, on the 2nd day to safeguard the eyes during the pupil dilation, and the 3rd day to serve as a necessary control upon the effect of such goggles.

3. Field experiments were carried out on three nights. No results significant with respect to the present study were obtained, but data on the performance of "night blinds" which were gathered at this time are being reported elsewhere.

\* At each administration, a total of eight drops was placed in each of the subjects' eyes. Two drops were given at five-minute intervals. The drug was Smith, Kline, and French Paredrine Hydrobromide Ophthalmic 1% with Boric Acid, provided by the Bureau of Medicine and Surgery.

## B. RESULTS:

1. Results of morning and afternoon adaptometer tests were averaged for each day.

2. The results on the Radium Plaque Adaptometer confirmed the expectations which had led to the use of additional adaptometers. The testing level of this instrument is too bright to yield data of any significant value for experimental work on small groups. Very few errors were made, and the majority of these appeared to be careless mistakes. The results for each day are presented in Table I of the Appendix. Further statistical treatment is not warranted by the data.

3. The results on NDRC Model II-A are strikingly similar to those on the Radium Plaque. For the present group of subjects, the testing levels were too closely spaced, and too bright to offer significant data. These data are also unsatisfactory because instrumental difficulties whose effect could not be determined were encountered on the third and fourth day. The results are presented in Table II of the Appendix.

4. The data obtained on the NDRC Model III Adaptometer are more suitable for statistical treatment. The mean "frequencies of seeing" are presented in Table I.

Table I

Mean "Frequencies of Seeing"\*  
NDRC Model III Adaptometer

	<u>Day 1</u>	<u>Day 2</u> (Paredrine)	<u>Day 3</u>	<u>Day 4</u>
Level I**	.94	.99	.97	.92
Level II	.85	.93	.81	.46
Level III	.50	.72	.46	.29
Mean 50% Threshold, Log Micromicrolamberts (by extrapolation)	3.60	3.53	3.60	3.76

Since skewness was least marked on Level III, these data have been chosen for intensive statistical treatment, although the same trends are apparent at all three brightness levels.

\* "Frequency of Seeing" - 3 Right minus Wrong divided by number of trials.

\*\* According to the best available calibration, these brightness levels are 3.90, 3.75, and 3.60 log micromicrolamberts.

5. Superficially, the results clearly show a marked increase in mean frequency of seeing on the second day, which may be attributed to paredrine, the experimental factor. They also show a marked decrease of less obvious origin on the fourth day. The effect on the second day is approximately as large as that which would be produced by an increase in brightness of .07 log units. The effect on the fourth day corresponds to that associated with a decrease of .16 log units.

6. It was deemed wise, however, to compare the present results with similar data obtained on these same men at earlier dates. There are three comparable sets of data obtained by the same test procedure, but by different operators, on 11 December 1943, 30 December 1943, and 6 January 1944. Table III of the Appendix presents these data, together with the present data, for the purpose of comparison. Table IV summarizes the differences and presents the critical ratios of each difference and associated rank order correlations. Table V gives the frequency of seeing of each subject.

7. Of the three earlier tests, two give results very close to those of the first and third days of the present experiment. On the third earlier day, however, these men show superior performance. No reason for this finding can be ascribed.

8. Paredrine, then, is not the only factor that can lead to the obtaining of significant differences. The data of 6 January are not readily explicable, but the data of 25 and 27 January may be attributed to paredrine and to lowered motivation respectively. On the last day of the experiment, the morale of the experimental group was markedly reduced. The men had not only lost interest in the laboratory tests, but more important, they were somewhat distressed over the possible effects of the drug upon themselves, despite reassurances.\*

### C. CONCLUSIONS:

The results of this experiment are equivocal. Given the experimental days only, one might conclude that the drug is effective, since the factor of motivation impeaches the data of 27 January. The data of 6 January remain unexplained. The reasonable expectation that the group would serve as its own control was not fulfilled.

\* One of the original experimental group of 18 turned in at the Sick Bay on 26 January with a complaint of headaches and "sore eyes" which he and some of his fellows attributed to the drug. After several days of medical, ophthalmological, and neuropsychiatric observation, he was sent to the Naval Hospital at Newport, Rhode Island, diagnosis being subdural hemorrhage.

## PART TWO

### Summary:

A second experiment was performed to determine further the effect of paredrine on night vision test performance. The results indicate that the use of this drug is associated with superior performance on tests of night vision.

### A. PROCEDURE:

1. In a second attempt to evaluate the utility of the drug paredrine as a possible aid to night vision, a group of 124 subjects, candidates for Submarine School, was employed.
2. Each man received two series of tests, on successive days. Testing followed the instillation of Paredrine Hydrobromide Ophthalmic 1% with 2% Boric Acid on one day, and the instillation of a 2% Boric Acid solution on the other. Sixty-four men on the first experimental day, and sixty men on the second day received paredrine. Ninety-seven men had never previously been tested, and 27 had served in a preliminary experiment.
3. All men were tested on the Navy Radium Plaque Adaptometer, with and without the addition of an extra filter, essentially neutral, of log density 0.20 LU. The use of this filter made the test sufficiently difficult so that a greater variation in test scores resulted, although it did not lower the intensity enough to permit evaluation of the threshold, or to yield a symmetrical distribution of scores.
4. At the time of administration of the drug or of the control solution, the subjects were informed that the purpose of the experiments was to learn more about night lookouts, and their cooperation was requested. No subject was informed of the nature of the drops administered. The effectiveness of this control was necessarily limited, however, by the markedly noticeable pupil dilation which was observable and remarked upon by the subjects after administration of the drug.
5. All tests were administered at least two hours after drug instillation, and consisted of 20 trials on the Radium Plaque Adaptometer, followed by 20 trials with the extra filter. The second test, under the opposite drug condition, occurred 24 hours later.

### B. RESULTS:

1. Graphs A, B, and C of Figure I present the cumulative frequency curves obtained from the data on all men. The irregularities of the curves obtained are a function of the relatively small number of men making up the experimental groups. The data are presented in Table VI of the Appendix.

2. These graphs indicate that the performance under the effects of paredrine is improved by approximately the same degree which would be obtained if the brightness of the plaque were increased by .20 log uul. Similarly, this increase in score is approximately as large as the improvement in second day scores over first day scores. Note, however, that low first test scores are not apparently eliminated by use of the drug as they tend to be on retests.

3. Owing to the typical skewed curves obtained, usual measurements of the reliability of differences may not be applied. For this reason, reliabilities have been evaluated by using a Chi Square technique to determine the significance of differences. It is assumed that no difference exists between the scores obtained after the use of paredrine and after the use of Boric Acid. The Chi Square calculation tests the credibility of this hypothesis. Two dichotomies, (a) 16/20 and above vs 15/20 and less; and (b) 20/20 vs all others; served as a basis for calculation. Table VII of the Appendix gives these raw data, and Table III A and Table III B the corresponding values of Chi Square. The calculations have been made on all subjects, and on the experienced and inexperienced subjects separately.

TABLE III.

Chi Square Evaluations.

Reliability of differences between proportions of men falling into each classification. (Correction for continuity of data has been made.)

A. Chi Square Reliabilities of differences of the 16/20 and above, vs 15/20 and less classifications.

	Test Level (App. 3.9 log uul)			Difficult Level (App. 3.7 log uul)		
	All	Exp.	Inexp.	All	Exp.	Inexp.
	S's	S's	S's	S's	S's	S's
Day 1	.27	.87	.10	4.78	.46	5.80
Day 2	.08	.00	.08	.78	.00	.71
Days 1 & 2	1.01	1.85	.14	4.90	1.06	3.52

B. Chi Square Reliabilities of the 20/20 vs all others category.

Day 1	1.01	5.19	0.00	14.18	2.60	12.25
Day 2	8.22	.09	7.05	19.08	.85	20.31
Days 1 & 2	7.85	5.28	3.56	38.30	5.04	32.75

4. The significant differences obtained on the difficult levels about both cutoffs seem clearly to indicate that paredrine has beneficially affected performance on the present tests. The effect is more marked on unsophisticated subjects.

5. Table VIII of the appendix include results which verify the statements of paragraph 2 above.

C. CONCLUSIONS:

1. The data of the ~~present~~ experiment indicate that the use of paredrine is associated with a definite improvement in performance, of the order of magnitude equivalent to that produced by a .2 LU increase in brightness. This may be compared with the .07 LU magnitude of effect indicated in the data of the earlier experiment on paredrine, all subjects in which were highly sophisticated.

2. The ~~present~~ experiment, ~~it may~~ be noted, does not indicate whether or not the use of paredrine may be associated with deleterious after-effects, or whether its utility is limited by the occurrence of refractive errors, which were absent in the present group.

3. It is interesting to note, in view of British reports, that none of the subjects in this experiment raised the slightest objection to the use of the drug.

APPENDIX

Table I

Mean "Frequencies of Seeing"  
Radium Plaque Adaptometer

<u>1-24-44</u>	<u>1-25-44</u> (Paredrine)	<u>1-26-44</u>	<u>1-27-44</u>
.93	.99	.98	.97

Table II

Mean "Frequencies of Seeing"  
NDRC Model II-A Adaptometer

	<u>1-24-44</u>	<u>1-25-44</u> (Paredrine)	<u>1-26-44</u>	<u>1-27-44</u>
Level I (20 trials)	.97	.97	.94	.95
Level II (20 trials)	.91	.95	.89	.90
Level III (20 trials)	.85	.93	.88	.79

Table III

Means and Standard Deviations:  
"Frequency of Seeing"  
NDRC Model III Adaptometer  
Level III (3.60 log uul)

<u>Date</u>	<u>Mean</u>	<u>Standard Deviation</u>	<u>S.D. of Means</u>
12/11	.51	.30	.08
12/30	.54	.25	.07
1/6	.83	.16	.04
1/24	.50	.22	.06
1/25 (Paredrine)	.72	.23	.06
1/26	.46	.22	.06
1/27	.26	.20	.05

Table IV

N.D.R.C. Model III Adaptometer  
(Level III)

Rank order correlations, differences, and critical ratios of the differences. (Significant differences are indicated by an asterisk).  
(Paredrine)

		12/30	1/6	1/24	1/25	1/26	1/27
12/11	Rho	.59	.59	.53	.76	.90	.61
	Diff.	.01	.31	.02	.20	.06	.23
	C.R.	.20	5.05*	.24	4.16*	1.63	3.75*
12/30	Rho		.77	.49	.80	.51	.36
	Diff.		.29	.04	.18	.08	.25
	C.R.		6.59*	.63	4.41*	1.29	3.76*
1/6	Rho			.38	.90	.54	.44
	Diff.			.33	.11	.37	.54
	C.R.			5.87*	3.89*	7.55*	10.84*
1/24	Rho				.58	.71	.70
	Diff.				.22	.04	.21
	C.R.				4.23*	1.00	5.20*
1/25	Rho					.73	.69
	Diff.					.26	.43
	C.R.					6.21*	9.84*
1/26	Rho						.64
	Diff.						.17
	C.R.						3.82*

Table V

NDRC Model III Adaptometer: Level III  
Frequency of Seeing Scores of each Subject.

Subject	12/14	12/30	1/6	1/24	1/25	1/26	1/27
Zi	.47	.40	.87	.40	.70	.57	.20
Wh	.87	.33	.87	.63	.87	.77	.53
Ze	1.00	.93	.93	.63	.97	.97	.43
Wa	.87	.33	.80	.17	.67	.33	.20
Br	1.00	.87	.93	.73	.90	.73	.47
Sc	1.00	.67	.87	.67	.83	.50	.70
Ha	.47	.80	1.00	.33	.90	.17	.17
Wy	.00	.27	.53	.10	.37	.07	.04
De	.93	.47	.93	.53	.83	.50	.37
Bi	.53	.00	.60	.33	.53	.20	.17
Ch	.87	.40	.93	.33	.77	.30	.04
Ya	.80	.27	.47	.73	.50	.20	.23
Dm	.73	.60	.73	.37	.60	.17	.07
Le	.87	.73	.87	.70	.77	.87	.13
Zl	.93	.80	1.00	.87	.93	.77	.53
Mi	.93	.80	1.00	.67	.97	.63	.47
Vn	1.00	.47	.73	.27	.10	.04	.10

Table VI

Distribution of Scores: RPA Adaptometer

Score (number correct in 20)	First Day				Second Day			
	Group A		Group B		Group B		Group A	
	Paredrine		Boric Acid		Paredrine		Boric Acid	
	RPA (3.90 LU)	RPA (3.70 LU)	RPA (3.90 LU)	RPA (3.70 LU)	RPA (3.90 LU)	RPA (3.70 LU)	RPA (3.90 LU)	RPA (3.70 LU)
	N	N	N	N	N	N	N	N
20	45	35	37	21	51	37	41	22
19	3	8	4	8	2	12	8	10
18	7	7	4	7	1	5	5	9
17	3	3	3	1	4	1	7	9
16	1	4	1	6	2	2	1	5
15	1	1	1	3		2	1	2
14	1	3	3	4				2
13			3	2			1	
12		1	1					2
11	1	2	2	2				2
10			1	3		1		1
9				2				
8	1							
7								
6				1				
5	1							
4 and less								
Total	64	64	60	60	60	60	64	64

Table VII  
R P A Adaptometer

Data used in Computation of Chi Squares  
Testing Hypothesis that No Difference Exists in Distribution  
of Subjects when Paredrine is Used

	REGULAR RPA (3.90 LU)						EXTRA FILTER (3.70 LU)					
	All subjects			Experienced			All subjects			Inexperienced		
	15/20	16/20	17/20	18/20	19/20	20/20	15/20	16/20	17/20	18/20	19/20	20/20
Paredrine	59	5	51	5	8	0	57	7	49	7	8	0
Boric Acid	49	11	35	6	14	5	43	17	28	13	15	4
Paredrine	60	0	41	0	19	0	57	3	38	3	19	0
Boric Acid	62	2	54	2	8	0	55	9	47	9	8	0
Paredrine	119	5	92	5	27	0	114	10	87	10	27	0
Boric Acid	111	13	89	8	22	5	98	26	75	22	23	4

	REGULAR RPA (3.90 LU)						EXTRA FILTER (3.70 LU)					
	All subjects			Experienced			All subjects			Inexperienced		
	20/20	20/20	20/20	20/20	20/20	20/20	20/20	20/20	20/20	20/20	20/20	20/20
Paredrine	45	19	37	19	8	0	35	29	29	27	6	2
Boric Acid	37	23	27	14	10	9	21	39	13	28	8	11
Paredrine	51	9	36	5	15	4	37	23	25	16	12	7
Boric Acid	41	23	35	21	6	2	22	42	18	38	4	4
Paredrine	96	28	73	24	23	4	72	52	54	43	18	9
Boric Acid	78	46	62	35	16	11	43	81	31	66	12	15

Table VIII

RPA Adaptometer  
Mean Frequencies of Seeing  
(corrected for chance)

A. All Means

		RPA (3.90 LU)	RPA (3.70 LU)
First Day	Group A (Paredrine)	.92	.89
	Group B (Boric Acid)	.89	.79
Second Day	Group A (Boric Acid)	.94	.85
	Group B (Paredrine)	.97	.94

B. Means: Equivalence of performance: Boric Acid at 3.70 LU and Paredrine 3.90 LU.

	<u>First Day</u>	<u>Second Day</u>
Paredrine group (3.70 LU)	.89	.94
Boric acid group (3.90 LU)	.89	.94

C. Means: First Day Paredrine Scores and Second Day Boric Acid.

	RPA (3.90 LU)	RPA (3.70 LU)
Paredrine Group: First Day	.92	.89
Boric Acid Group: Second Day	.94	.85
Paredrine Group: Second Day	.97	.94
Boric Acid Group: First Day	.89	.79